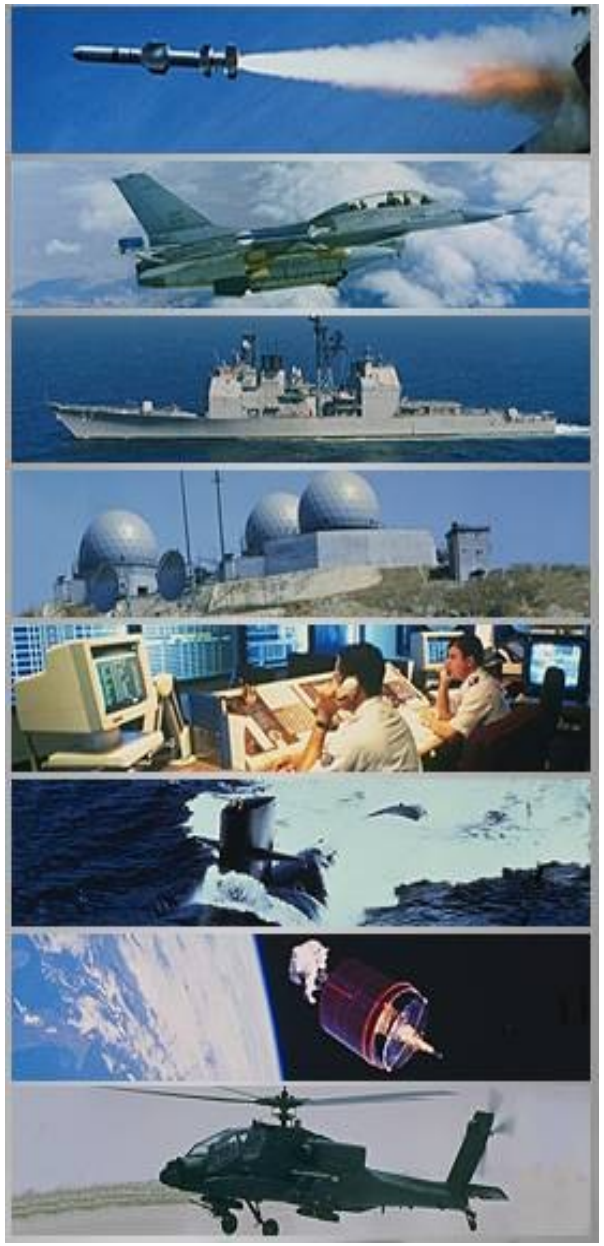
Defense MicroElectronics Activity

DMSMS Tutorial
Misc. Technology Issues

(Session 3)



Application Specific ICs (ASICs) and DMSMS

DMSMS in Recent Generation Designs

- Why are recent generation designs so vulnerable to DMSMS?

- They consist primarily of ASIC devices
  - Virtually sole source
  - Custom ASICs have limited supply – typically one fabrication run
  - Unique design eliminates component supply “sharing”
  - Very difficult to redesign
    - High density, complex devices
    - Design documentation is critical but often deficient
    - No correlation between part numbers and design functions

What Options are Available?

- Direct FFF replacement? ***No!***
  - ASICs perform specific functions – with the exception of FPGAs, finding an equivalent device number will not suffice
- Exhaustive database search for second source? ***No!***
  - Custom designs render search of other programs for equivalent devices useless
- The only remaining option? Various levels of redesign
  - Component
  - Circuit Card
  - System

The Dilemma of ASIC Redesign

- Recent program upgrades experienced obsolescence within two years – why go through the same process?
  - Valid argument - Without a change in approach, the solution will again be temporary

- Insufficient data exists on the obsolete module, resulting in prohibitively expensive redesign proposals
  - Unfortunately, this is a common occurrence

Recommended Approach to ASIC Redesign

- Apply cutting edge tools & methodologies to accurately characterize legacy component
- Scrutinize components to select least vulnerable
  - Select components commonly used by industry to provide greater assurance of future availability
- Provide complete, verifiable, vendor-independent documentation
  - VHDL, Verilog, EDIF, etc.

Radiation Hardness Parts

Radiation Hardness (Rad Hard) Parts

- Radiation effects are a concern for:
  - Space environment
  - Nuclear applications
  - High energy particle physics
- Radiation effects on electronics induce:
  - Total Ionizing Dose (TID)
    - Degradation or failure as a function of ionizing radiation accumulation (i.e.: month, year….dose rate dependence)
  - Single event effects
    - Relatively instantaneous device upset or destruction
    - (latchup, burnout, gate rupture)
  - Displacement damages
    - Degradation of solar cells, CCD, optics….

Rad Hard Concerns with COTS

- Undetermined (and often high) sensitivity to radiation effects
- Packaging effects
- Variability
  - A COTS manufacturer has no reason to control the technology parameters that condition the radiation hardness
  - Process is likely to be modified at anytime
  - Date codes are not reliable
- Obsolescence
  - COTS suppliers constantly introduce new products (2 years for Xilinx and Actel gate arrays)
  - Hardened systems:
    - Take a long time to develop
    - Have a long life cycle (more than 10 years)
      - 7 upgrades for a 30 years program!
    - Consider a lifetime buy when possible.

Plastic Encapsulated Microcircuits (PEMs)

Plastic Encapsulation

- Plastic encapsulated microcircuits (PEMs) have advantages and disadvantages

Advantages

- Potential lower cost
- Greater variety of functions
- Rugged
- Light weight
- Higher packing density
- Tc close to PCBs
- Automated assembly methods

Disadvantages

- Non-hermetic
- Limited temperature range
- Higher thermal resistance
- Controls necessary for board assembly
- Sensitive to internal thermal expansion stresses
- No universally-accepted industry standards
- Moisture absorption is a concern

What are PEMs & HSMs?

- Plastic Encapsulated Microcircuits
  - Encapsulation / Coating is in direct contact with the die, lead frame, signal traces, interconnects
  - Molded, potted, or coated semiconductor die or hybrid ICs

- Hermetically Sealed Microcircuits
  - The cavity is sealed
  - Die, lead frame, signal traces, interconnects, and barrier layers are not in contact with the metal or ceramic package

PEMs: Pros & Cons

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PEMs: Bottom Line

- Particular attention should be given to:
  - Storage requirements for production and repair facilities
  - Environments for:
    - Assembly
    - Repair
    - Operating
    - Storage

- The primary concern is moisture ingression and the resulting problems
  - Use of a conformal coating will reduce moisture ingression to more acceptable levels

- Take into account the higher thermal resistance of PEMs versus HSMs
  - Changes in junction temperature
  - Affects on thermal derating and reliability

Uprating / Upscreening

Uprating / Upscreening "Definitions"

- Uprating is the process to reduce the risk involved in using components and/or systems outside the manufacturer's environmental specifications. These risks can be segregated into: (*IEEE Wright/Humphrey/McCluskey*)
  - Die Reliability: the capability of the die to operate in the desired environment without physical degradation by mechanisms such as electro-migration or oxide breakdown.
  - Package Reliability: the capability of the packaged component to withstand exposure to the desired environment without failing.
  - Electrical Performance: the capability of the component to perform its electronic function in the desired environment.
- Uprating is a process to assess the capability of a device to meet the performance requirements of the application in which the device is used outside the manufacturer's specific range. (*IEQ TC 107/3/PAS*)
- "Upscreening" is sometimes used interchangeably with "uprating", but is also used to identify the physical testing of individual parts for use outside that part's specifications.

Questions or Comments?